New Zealand Fixed-wing agricultural aviation

Safety analysis update

Safety performance report and accident analysis

SB 1

In 2013 the NZAAA and the NZHA initiated a project where we analysed all of the agricultural and helicopter accident data held in the CAA database from 2000 to 2012. For every accident, we collected all of the available information and after careful analysis from many experienced pilots we assigned causal factors to each one. Since then we have promulgated four safety bulletins to the helicopter industry, each one directed at a major area of accident risk including wirestrikes and helicopter weight and performance.

Now the time has come to do the same for the fixed wing operators. The information in this bulletin is important to all operators and pilots. It tells the story of our safety performance for the last 14 years. That is the work we did in 2013 plus the latest two years of data. So it's the story of the **125 accidents** that have occurred in the sector since 2000. It explains how those accidents occurred and, importantly, what can be done to avoid them happening in the future. This bulletin represents our earnest commitment to this principle: that we *must* improve from the mistakes made in the past. It also is an ongoing commitment: we intend to publish several of these bulletins, each one directed at the major areas of accident risk fixed-wing operators face.

The Agricultural Aviation Sector Risk Profile

The commitment to this project is in line with the Sector Risk Profile completed in 2013. That exercise identified that we need an ongoing process to determine the main risks we face in the industry and mitigation strategies for those risks. For those in need of a refresher (it was a while ago now!), on the basis of interviews with many pilots, operators, and other participants, the profile identified the following risks in agricultural aviation:

"…there is a safety culture problem where productivity is emphasised over safety";

"… there are few incentives or means for operators to manage safety risks in areas such as fatigue and non-technical skills"; (ie Human Factors)

"… there is a lack of a system-wide approach to safety in the sector"; and

"…operators need leadership to guard against lowering of standards and culture".

And at the time we also said:

"…we need to encourage and support the development of an industry 'BEST PRACTICE' publication";

"…need to develop and implement customised information on human factors in the industry"; and

"…proactive, industry-wide communications regarding safety matters should be undertaken".

Please consider this as another important step towards an industry-wide approach to safety management, and an ongoing one.

Sector performance over time

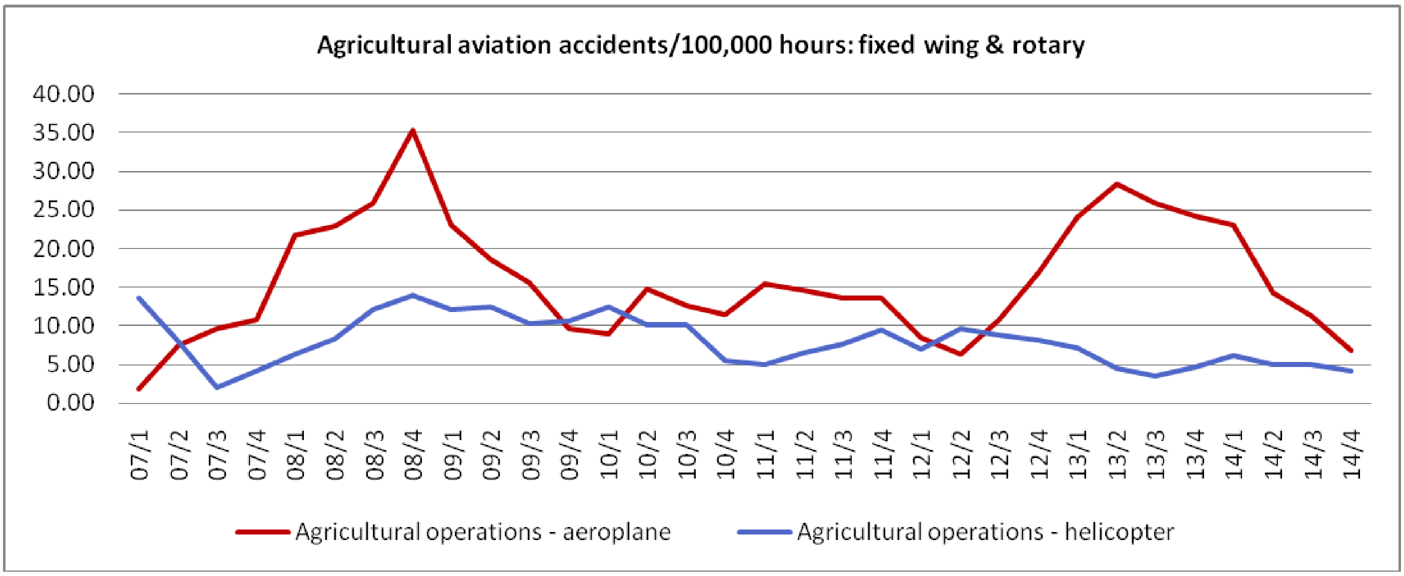
This is a high risk industry. But just how 'high risk' it is might surprise you: in 2001 a research article published in the New Zealand Medical Journal stated the following:

"Most strikingly, commercial pilots and related workers, particularly agricultural pilots and helicopter pilots, had the highest rates of death, with rates 27 to 210 times that of the population overall". [i]

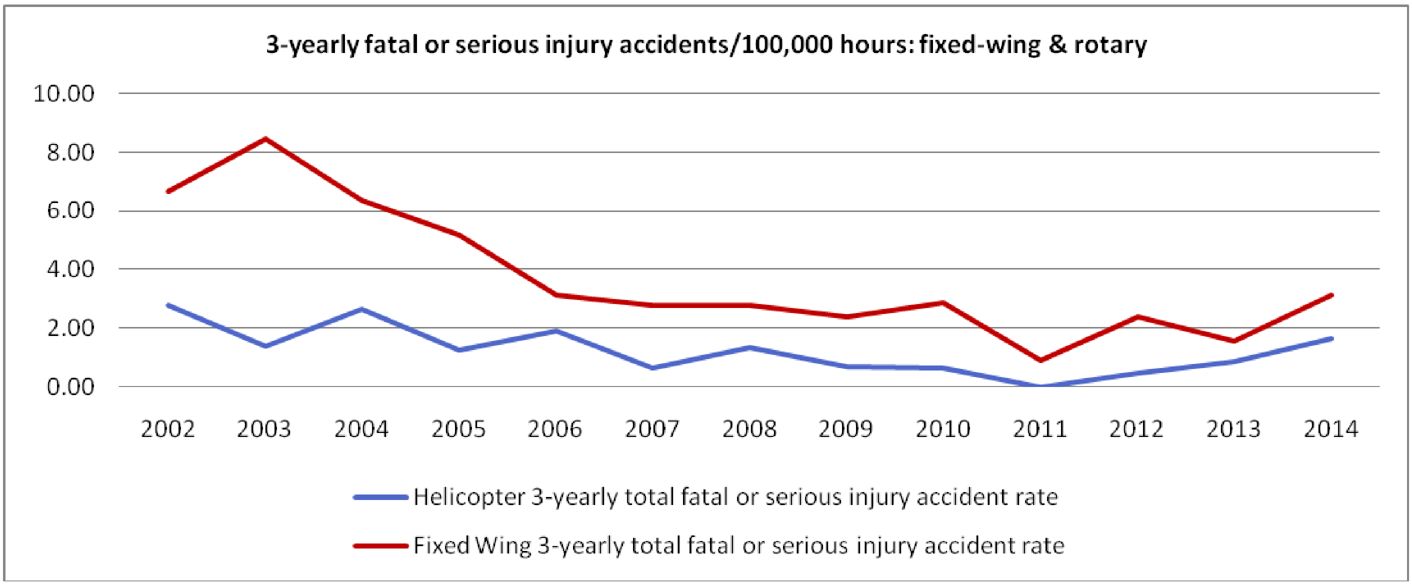
What is the situation in the years that have passed since then? Since 2000, there have been 125 fixed wing agricultural aviation accidents resulting in 14fatalities. Based on the number of agricultural and chemical rated pilots with a current medical, we've estimated that at any given time (and we think this is a generous assessment) there are around 300 active pilots in agricultural work. Taking all the data, that means there are 3 deaths for every 1000 agricultural pilots, or nearly one death in the industry per year.

We want to make it clear how high this fatality rate is. According to the Worksafe website the most dangerous jobs in New Zealand have been in Agriculture *(this excludes agricultural aviation)*, Forestry, and Fisheries. In 2014 their fatality rate per 1000 workers was 0.17. Our fatality rate per sector participant appears to be some 17 times higher than this. We can't confirm it because some industries don't collect data to the extent that we do, but it seems very likely that this work we do carries *the highest risk of occupational death than any other industry in the country.*

But it isn't all bad news. As the graph of accidents/100,000 hours below shows the industry's safety performance has been getting better since a recent big spike in the accident rate in 2013.



Taking a longer-term view and focusing on critical accidents shows further encouraging results:

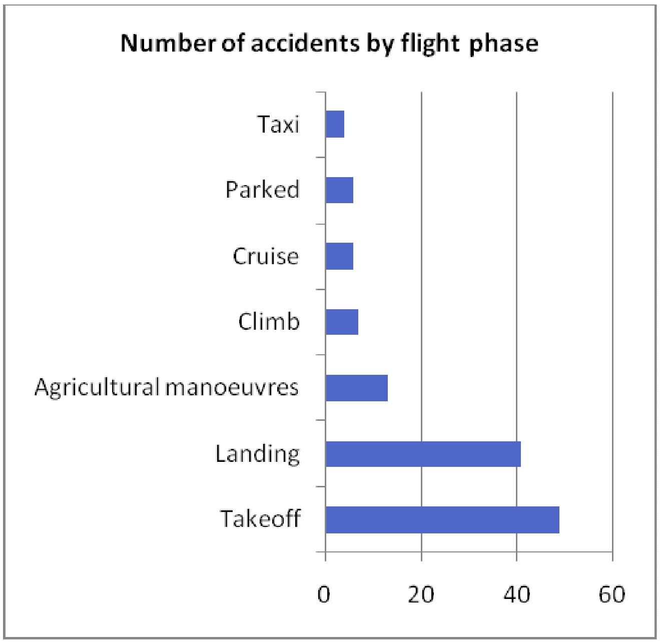


To put that information into plain English, in 2003 the safety performance was such that we would expect over eight fatal or serious injury accidents in fixed wing agricultural operations every three years. As of 2014, we would expect around three such accidents every three years, so collectively we have been making big improvements in safety performance as an industry over time.

The accident data analysis

In any accident there are always a number of factors that come together and contribute to 'what went wrong'. Our approach has been to analyse all of the available information for each accident and then to assign an *opinion* of the primary cause and the other main contributing factor. What we end up with is a list of the main accident risks presented by fixed-wing agricultural operations. Before getting into that, here is some general information on the accident data:

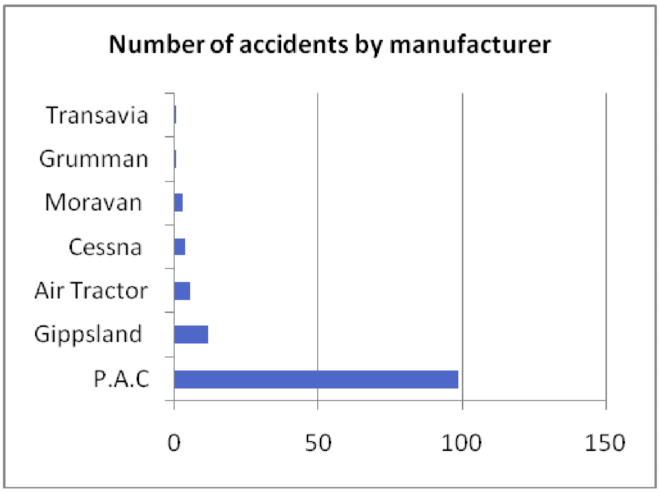
Flight phase

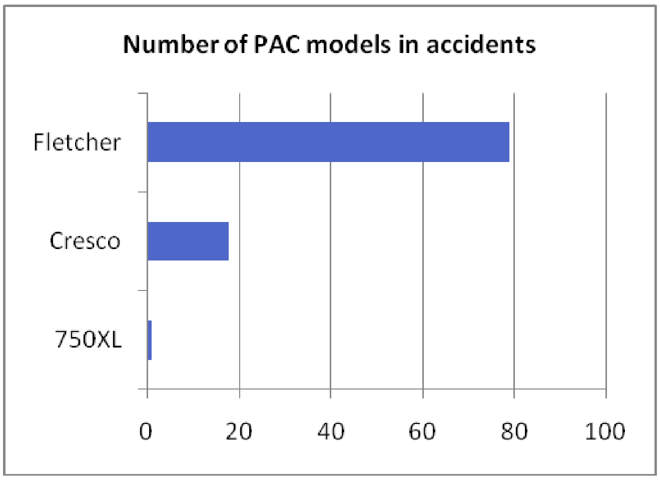


So the usual suspects of takeoff and landing are well represented there. 'Agricultural manoeuvres' basically means spray runs and turns, etc. Of those accidents that happened on the ground 8 were collisions with the loader vehicle.

Aircraft make and model

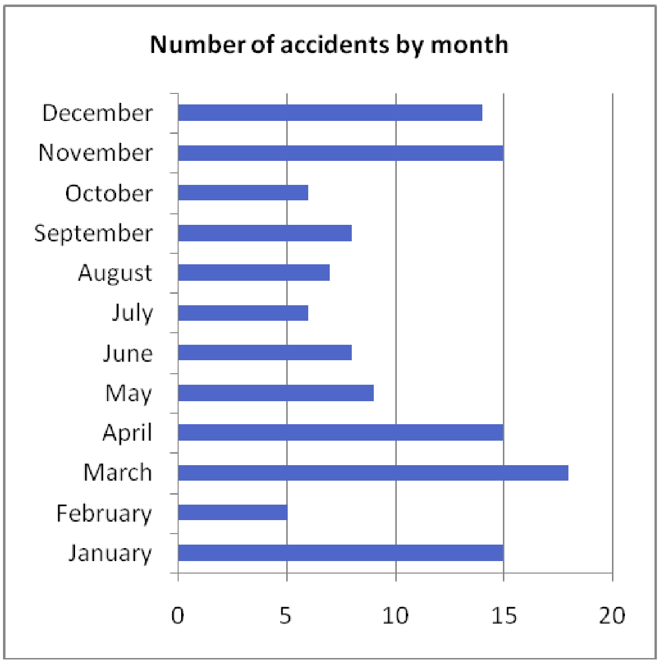
Naturally the majority of accidents have involved Fletchers and Crescos because this type dominates the industry.





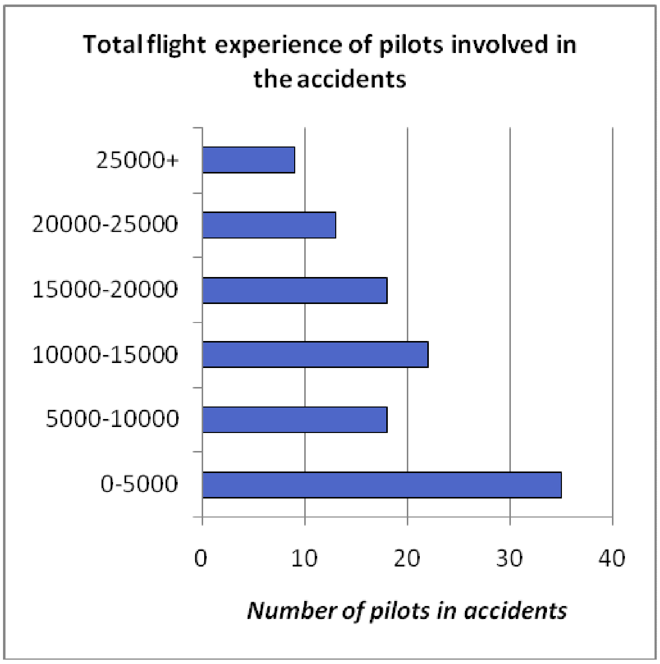
Seasonal factors

Curiously February has historically been the safest month with 5 accidents over the period

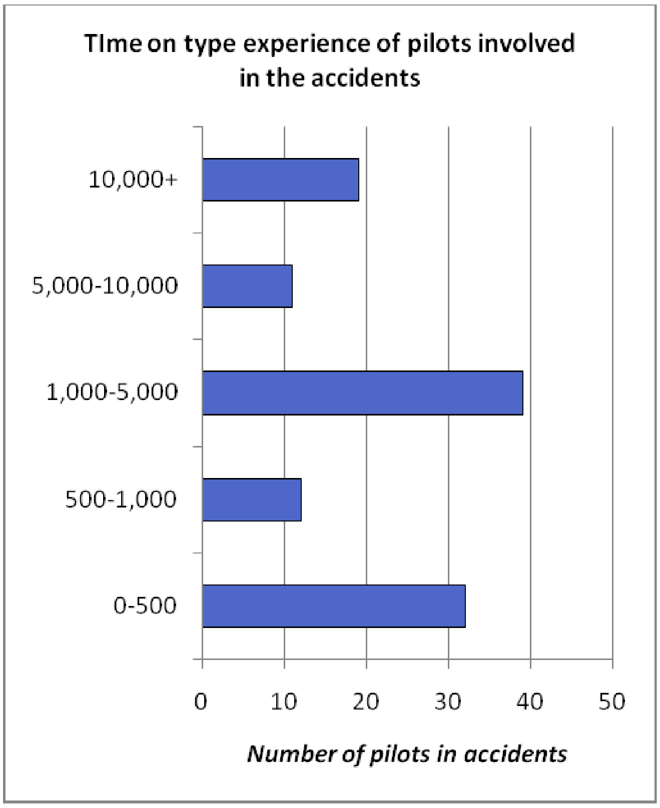


Pilot experience

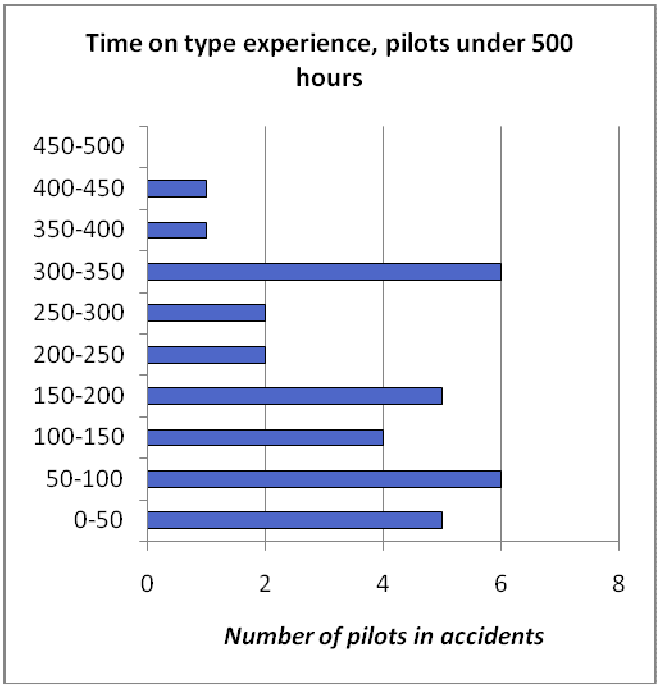
When we looked at the flight experience of the pilots involved in the accidents we identified that total flight experience is not necessarily a protective factor: in 62 of the accidents the pilot had more than 10,000 hours under their belt.



We identified that total experience *on type* is also a feature of these accidents. 32 of the pilots involved had less than 500 hours on type, that's a quarter of the total accidents. 44 had less than 1000 hours -35%.



The next chart shows the pilots with fewer than 500 hours on type:



Accident types

When accident data is recorded, various codes are assigned that describe the nature of the accident – "what went wrong". The table below shows how the accidents we analysed are distributed across the categories, in order of prevalence.

Accident category	***Total accidents***
Collision with other object	49
Collision with terrain	21
Takeoff or landing accident	19
Gear collapse	17(Remedied some years ago)
Engine power loss	8
Airframe failure	4
Component or system malfunction	4
Loss of control	3

From there, we can take a closer look at each type of accident to get a clearer picture of what is going wrong. Below, for example, are more specific data for the most common type of fixed wing agricultural accident, 'collision with other object'.

Collision with other object accidents

Object involved	***Total accidents***
Fence/fence Post	17
Vehicle	11
Embankment	9
Tree	5
Wire/cable/powerline	4
Animal (not Bird)	2
Ditch	1

What we aim to do is to promulgate safety notices like this one that focus on each of the main accident types. You can think of this as an industry-wide 'risk register' that is based on information derived from the accidents that have accumulated over the years. You can use this to review your own risk management procedures and to identify the hazards you face. And there are a lot of hazards: because we operate at low levels, over difficult terrain, and in changing environmental conditions, we are exposed to a greater number of hazards than other sectors of the industry. The accident below is a very good illustration of this:

> **July, 2001. Wirestrike.** The pilot was on his third and last load. The property was traversed by a set of high-tension power lines, and it was necessary to operate in close proximity to, and under, the wires. On the first two loads, the pilot had flown under them 10 times at a height of 1 - 2m agl. Lining up to commence the third load, he decided to alter the spray pattern to avoid crosswind drift of the spray onto the windshield on subsequent runs. About 500 m into the run, two paradise ducks rose from a creek in front of the aircraft, and the pilot reacted instinctively by climbing and turning left. The right wing clipped the lower conductor, causing the aeroplane to roll inverted and strike the ground. The aeroplane was destroyed by impact forces and subsequent fire, but the pilot was able to vacate with only minor injuries.

There you have wire hazards, low flying hazards, weather (wind) hazards, wildlife hazards, and human factor hazards all coming together in the space of a a second and leading to a major accident that the pilot was very lucky to escape from. There is a simple conclusion to draw from this – no matter how experienced you are or how familiar with your aircraft, airstrip, or location you should always be aware that this is and always will be highly dangerous work (as we said before, probably the most dangerous in the country based on the data). So there is no room for complacency, and every operator and pilot should appreciate the importance of good safety management procedures.

Takeoff accidents

With this issue we are going to focus on the most frequent type of accident by phase of flight: the takeoff accident. We identified **49** of these in the dataset, **or nearly 4 per year.** This is a lot but we must remember that the Ag Sector makes about 500,000 takeoffs each year. In the next table are our opinions of the primary causes of these accidents:

Opinion of cause	***Number of takeoff accidents***
Overloaded for conditions	19
Airstrip conditions	8
Airframe failure	6
Engine failure	4
Human factors	4
Collision with loader	2
Inappropriate weather conditions	1
Loss of control	1
Pilot Incapacitation	1
Sunstrike	1

It is fair to say that the airframe failures refer to undercarriage failures that occurred in the early 2000's and have been subsequently corrected.

Something that really stood out to us from many of the accidents relates to human factors. Recall from the Sector Risk Profile we said that the industry:

"…need to develop and implement customised information on human factors in the industry."

In many cases it was clear that pilots' **situation awareness** had a major role in the accident. Most people have a general idea about what this means but we'd like to introduce a simple version that is relevant to our industry.

There are three elements:

Knowing the state of the environment you're working in. For example, knowing where trees are relative to your runs; knowing what condition the airstrip is in; knowing how much fuel you have on board.

Knowing what state it will be in in the future. For example, knowing a soft strip's condition will degrade after a few loads; knowing where the loader truck will be in the 5 seconds after loading; knowing wind direction is forecast to shift.

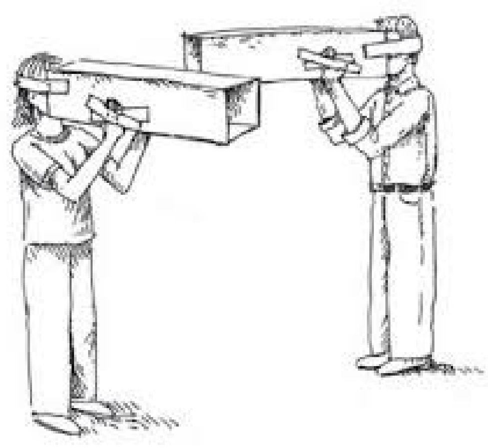
Knowing the impact all of this will have on your work. For example, knowing what a fresh crosswind or a softening strip means for your takeoff performance ; knowing what a change in temperature means for the amount of product you can safely carry.

A good summary of how to manage situation awareness is this:

"Your aircraft should never be anywhere that your brain hasn't been 1 minute earlier".

All pretty straightforward stuff on paper. But in accident after accident agricultural pilots don't get it right. From our analysis this happens for a number of reasons, but there are three main ones in fixed wing agriculture. These are listed below, along with some accident examples that illustrate how they can operate.

Fixation: focusing too much on the task means what is going on outside the aircraft is neglected.



The classic example of how this can lead to an accident are the 'loader collision' accidents, when the pilots focuses on the takeoff roll and neglects to check that:

a) The loading is complete;

b) The loader is clear of the area.

February, 2011. Loader collision. As the pilot applied power to initiate takeoff, the aircraft's tail plane contacted the loader vehicle. The loader vehicle may have been positioned too close to the aircraft and the driver was slow to reverse away when the aircraft started to roll. The pilot in command should have monitored that the loader was clear of the aircraft.

And of course there are also plenty of loading accidents where instead of the pilot it's the loader that stops concentrating on what is going on around them.

The fixation problem is also a factor in many overloading accidents. The focus on getting the job finished in minimal time and cost means the load limit is exceeded for the conditions – sometimes through neglect, sometimes quite deliberately.

Autopilot: complacency sets in after time and pilots can stop thinking about identifying hazards and threats.

The repetitive nature of the work makes this a big risk for pilots. A lot of these accidents happen after at least a few loads have already been made and the pilot and ground crew have established a 'rhythm' on the job. The trap is that they can stop thinking about what is going on around them, most especially with regard to:

a) Changes in the weather, most especially wind direction and intensity, and temperature;

b) Deteriorating strip conditions after a few runs.

December, 2009. The aircraft was spreading lime and reportedly struck an object shortly after takeoff. Aircraft struck a fence and crashed upside down 80 metres from the end of the strip. The pilot was trapped in the wreckage and sustained minor injuries. Cause: The aircraft failed to accelerate on takeoff as it had done in previous departures (over 80 loads had already been sown that morning) from the airstrip. **This was mainly due to the load carried for the (changing) meteorological and operational conditions.**

Below is an example of how degrading strip conditions can lead to trouble:

August, 2000. The aircraft was applying slurry fertiliser. The airstrip was wet and soft at the threshold end so the pilot elected to carry light loads of around 400 kg. On the last flight, the aircraft took off into a 10-15 knot south-westerly wind, which was increasing with the arrival of a front. Just after lift-off, the aircraft sank back on to the strip about 30 m from the end, and the soft ground prevented further acceleration. Beyond the end of the strip was a ravine, and the aircraft struck the far side about 2 m below the lip. The pilot had commenced jettisoning the load as the aircraft sank back on to the ground, and the load was virtually gone by the time of final impact.

Distractions: anything that takes up your attention while on the job reduces your situation awareness.

November, 2001. The aircraft was approximately a third of the way down the airstrip on its takeoff run when the pilot became aware that the control lock was fitted, but he was unable to remove the device. The rough surface of the airstrip coupled with sufficient nose down force to the nose resulted in collapse of the nose gear, and substantial damage to the aircraft. The pilot was under pressure to complete a flight detail within a certain deadline and did not complete all items on the pre- takeoff checklist.

The other way that situation awareness leads to collisions is how we can sometimes not perceive the interaction between things in the operating environment. A classic example is how wind can initiate an accident sequence. Changes in wind direction and intensity are hugely prominent in the data especially tailwinds on takeoffs.

September, 2004. It was reported that the aircraft was hit by a tail wind gust during takeoff. This resulted in the plane hitting the ground and going through a fence. The aircraft then went over a 50 metre bank before coming to a rest on a creek bed.

Finally, the number one thing that the takeoff accident data shows is that there has been a sustained and ongoing problem in the industry where we have failed to perceive how the load carried will affect the performance of the aircraft in the conditions: overloading. This bears out the truth behind what everyone said in the Sector Risk Profile:

"Risk no. 7: Degraded aircraft performance due to routine overloading of aircraft is prevalent amongst agricultural aviation operators, leading to unsafe operating margins and a higher risk of an accident"; and

"…there is a safety culture problem where productivity is emphasised over safety"

Resilience against the risk

In this section we talk about some strategies that can be used to reduce the risk of these types of accidents occurring again. These strategies reflect the lessons we can learn as an industry from the accidents we have analysed.

How many of our take off accidents are caused by a desire to be the most productive? The "big ton" guy is often the same guy who is lying in hospital with a broken leg. An overactive ego is one of our worst enemies in the cockpit. Set load sizes that give you a margin because if you go looking for trouble, it will find you.

35% of our take off accidents were caused by hitting a fence. In 2001 NZAAA ran a campaign to get rid of the fences at the end of airstrips but that relied on pilots to enforce the requirement and clearly, many didn't. How hard is it to tell a farmer that a fence has to be dropped? Having a fence right on the end of an airstrip means the farmer is not providing a safe workplace and so you have the strength of H&S legislation behind you when you ask for it to be removed. We know of one operator who used to carry a snig chain in his loaders and simply removed the fences himself.

If an error is made on takeoff and there is no fence at the end, the outcome is often just a surprise but if an error is made and there is a fence there then the consequences are nearly always catastrophic. Do you really need to accept this risk?

And what can we say about changing weather conditions? That still catches many as evidenced by the accident reports that talk about unexpected tail wind on takeoff. A trained Ag pilot should always be monitoring the wind as the day progresses. The "markers" he sets up will give the clue to the changing conditions usually well before they are felt on the airstrip. There is rarely any excuse for being surprised. The astute pilot who is situationaly aware will never be surprised by a wind change.

There was a lot of work and debate that went into the “Air strip Guideline.” *(Safety Guideline Farm Airstrips and associated Fertiliser Cartage, Storage and Application)* The standards that are quoted there came from bitter experience with lessons written in blood. As discussed earlier, AG Aviation is a dangerous occupation. If the Airstrip Guidelines are followed then very nearly all of the take off accidents would be avoided. So just who is making the occupation dangerous?

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[i] Feyer, A., Langley, J., Howard, M., Horsburgh, S., Wright, C., Alsop, J. and Cryer, C. (2001). The Work-Related Fatal Injury Study: Numbers, Rates and Trends of Work-Related Fatal Injuries in New Zealand 1985-1994. *New Zealand Medical Journal.* 114: 6-10